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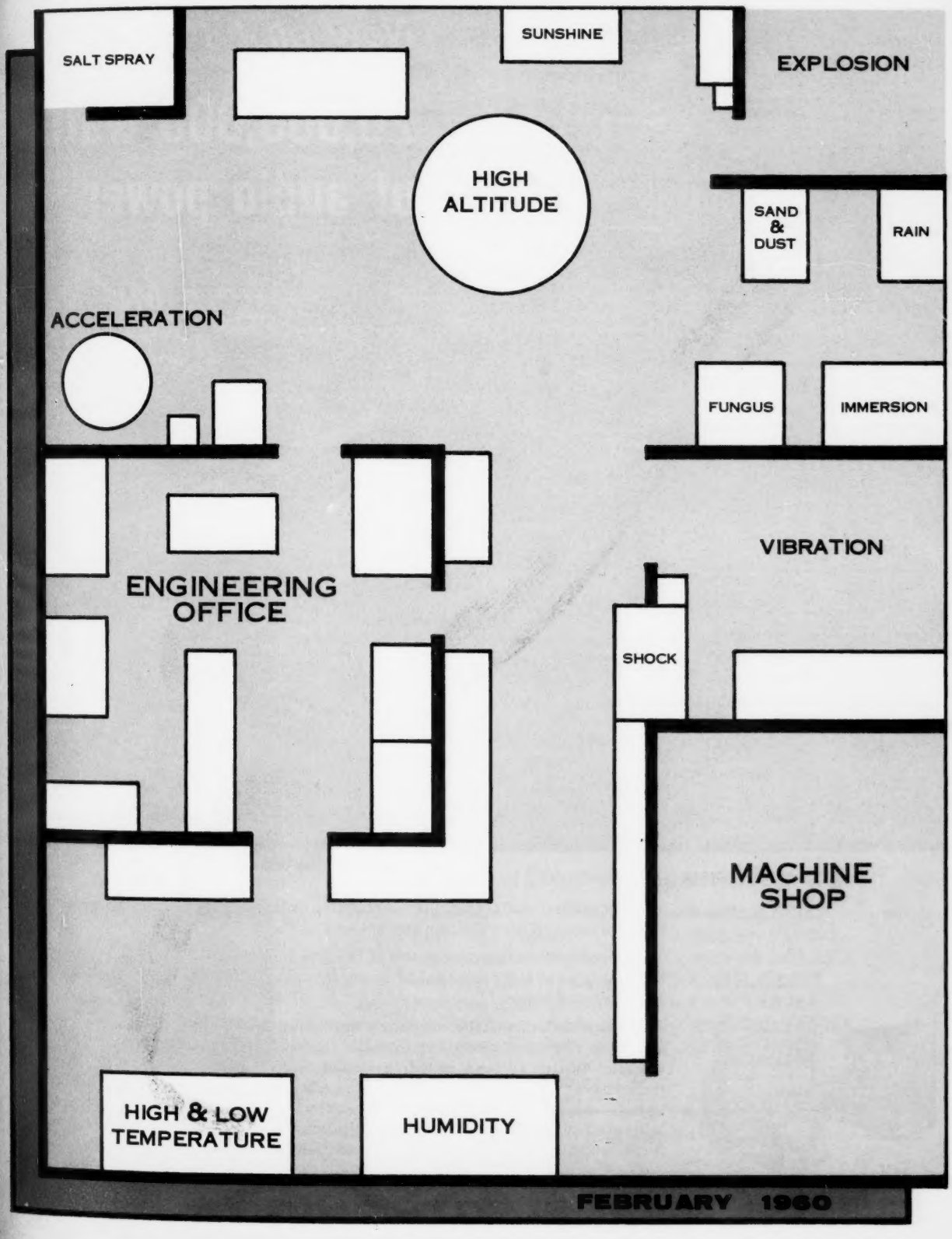

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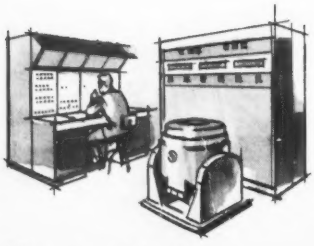

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FEBRUARY 1960

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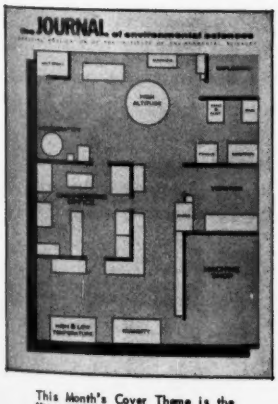

This Month's Cover Theme is the "Management of an Environmental Laboratory."

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MANAGEMENT of an ENVIRONMENTAL LABORATORY

by G. BROWN
U.S. TESTING COMPANY

One of the major subdivisions of the field of Management is Laboratory Management. Environmental Laboratory Management is, to a great extent, covered by this subdivision, but there are a number of distinct problems peculiar to this type of laboratory which warrant its being considered as a subject in itself. In the interest of a well-rounded presentation, many of the subjects covered apply generally to Laboratory Management, but greater emphasis will be placed upon the problems created by the introduction of environments.

Of course, the problems and their solution vary somewhat depending upon the size of the laboratory, its parent organization and the nature of the product or products it is required to work with. To avoid too general a presentation, most of the following discussion will assume a "typical environmental laboratory" that consists of between twenty and fifty people, is a division of a manufacturing company and the principal product of concern is small "black boxes." Administration of the laboratory will be discussed first, followed by operational considerations, and personnel management.

Design of the organizational structure is of primary significance. I have done a great deal of experimenting in organization design over the past years and will probably continue to do so as long as I am in this profession. Staff-line type design attempts solution of one of the major problems of Laboratory Management; advancement of technical people without limiting their technical technical effectiveness by excessive administrative burden. The concept is not entirely unique, in fact there are a number of large industrial laboratories presently using similar structures, with the exception of the Laboratory Manager on top. The philosophy is to provide two parallel lines of advancement, one principally technical, the other administrative. In the more commonly used form, the management of the laboratory is the joint responsibility of the two Directors. My experience has been that it takes two exceptionally compatible people to make this work as intended. Depending upon the individuals, one will usually dominate or neither will, or both will try, and there is a consequent animosity or lack of decision. Decision can only be made by one man. He can be advised by several, but if you want effective decision, make it the clear responsibility of one individual.

The positions of both Technical Director and Director of Administration are staff rather than line. The Technical Director is responsible for the technical quality and progress of the work done in the laboratory. He is also responsible for selection, training and progress of the professional personnel. The Director of Administration is responsible for all administrative functions of the laboratory and all of its sections. He is also responsible for the direct supervision and training of all laboratory administrators and support personnel, such as clerks, typists, etc.

Thus, your professional people are almost completely freed from administration. If you have specialists whose functions apply to several sections, such as instrumentation, statistics, etc., they can be placed on a staff level under the Technical Director.

Utilization of the staff concept results in a direct line responsibility between the Laboratory Manager and the Section Chiefs. The basic philosophy of the design is that the Section Chiefs are the key operational people and their level in the structure is the vertibrae of the organization. The function of the positions above that line is to guide, advise and assist them to perform their function effectively. The staff and management function is to support them and to act as a liaison with

higher management. This concept has its roots in the factor of motivation which will be discussed later.

A considerable problem lies in determining the structure of the sections. Should the sections be established along product lines such as electronics, mechanics or hydraulics, or possibly along function lines such as climatic environments, mechanical environments, etc., or still another possibility – by projects? Here the particular circumstances of each laboratory must determine the optimum breakdown. I have usually found a combination to be necessary. If a project is large enough it should have sectional status, but usually the sectional breakdown is along product lines at the Engineering level. I say at the Engineering level because an exception is the Testing Section, which is on the same level and constituted of all of the technicians and engineers actually conducting the testing. Thus all work to be done in the laboratory is designed by the product or project sections and transmitted to the Test Section Chief who then assigns the work in the laboratory. The basis and working of this concept will be discussed later.

In discussing controls I will assume that the goal is economical operation of the laboratory. Even if your laboratory is classified a pure burden function, efficient and economical operation should be your goal. A lack of this viewpoint is not only reflected in terms of dollars, but in the efficiency and technical quality of the work as well. To be an effective manager, you must have control of the laboratory, not only in the authoritative sense, but from the standpoint of knowledge of status of operations as well. The subject of controls is an extensive one that would be a paper in itself if thoroughly explored, so I will discuss only a few that I consider critical.

The type of controls needed by the Laboratory Manager need not be precise, but they must be current. If the information is not timely, it is frequently too late to take the corrective action required. Another requirement is that the information be presented in as simple a form as possible and be capable of evaluation in as short a time as possible, preferably seconds.

The above requirements are best accomplished by graphic presentation, as long as too much information is not presented on any one graph. I have found the most effective presentation to consist of two basic types of information, budget or projection and actual experience.

In an environmental laboratory the most flexible and critical cost control factors are personnel and their utilization. The optimum ratio of direct to indirect labor will vary considerably depending upon the nature, function and size of the organization. But, for the sake of discussion, let us assume that the control point is 85% of total labor. This then becomes the budget represented by the dashed line. Actual experience is represented by three solid lines, preferably of different color. The black line represents labor charged directly to projects. The green line represents non-productive, indirect labor, such as lost time, vacations, holidays and sick leave. The red line reports productive, indirect labor such as supervision, staff, clerical and typing personnel, janitors, etc.

Because of the hyper-critical significance of this labor ratio in our business, this chart is on a daily basis. But you can easily see that not more than two seconds of the Manager's time is required to evaluate the graph, unless it indicates that something is awry. A glance at the direct labor line will indicate whether it is above budget. If it is not, we then look to the other two lines to see whether productive, indirect or non-productive, indirect is responsible. Thus, the trouble spot is easily identified and appropriate and timely action can be taken.

Another sensitive spot which must be kept under control is status of projects or contracts. Here, again, the relationship of budget and performance is the measuring stick, but the problem is a bit more complex because the relationship between projected and actual expenditure and progress must be considered. Another complicating factor is the difficulty of measuring progress on many projects. Because this type of chart is more complex and time-consuming, we restrict its use to projects over ten thousand dollars ($10,000.) and maintain it on a semi-monthly basis. There are a number of other factors such as materials expenditures, distribution of personnel classifications, etc. that could be considered, but in the interest of simplicity, only expenditures in terms of labor hours, percentage of completion and time are considered.

As previously mentioned, there are many other controls available and needed, but we cannot explore this subject further here. I will leave this subject with a word of caution-do not overcontrol. Judgment must be used to determine the need for and usability of controls or your operation can become practically paralyzed and spend more time and effort drawing charts than it does testing.

Little can be said here about systems and procedures from a paper flow standpoint, because these are in most cases determined by the laboratories parent organization. But, where the control or design of systems is the Manager's responsibility, I would like to suggest that it be critically examined before being put into effect.

One of the principal functions of management is planning. But, unless the manager is extremely careful, he will become so absorbed in daily problems and details that, in actuality, the job will literally be running him. When this happens, the manager's effectiveness becomes severely limited and efficiency and growth of the laboratory occur in spite of him, if they occur at all. This danger cannot be over-emphasized, because it is so insidious in nature. You will probably be surprised if you

ask yourself at the end of each day, "Did I run the laboratory today, or did it run me?"

One of the most effective ways of avoiding loss of control of the situation is to be aware of the danger. Insofar as positive action is concerned, selection and training of an adequate staff is essential. Of course, the best staff in the world will not help the situation unless there is an appropriate delegation of functions and authority. Some authorities advocate that all functions be delegated with retention of higher management liaison and guidance responsibility only. Strict adherance to this principal is seldom practical or possible in the type of organization we are considering here. But, there must at least be sufficient delegation to allow the manager freedom for charting the course of the laboratory.

There are many definitions of planning, but I feel the simplest and most usable to be - Considering Where Your Organization Wants, Or Must Be In The Future, From The Reference Point Of The Present. In other words, where are we now, where are we going and how are we going to get there.

To attempt to advise you how to plan would be somewhat presumptuous, but I can point out some of the major areas requiring conscious planning effort, and call to your attention some of the factors which must be taken into consideration.

A rather elementary, but essential, factor of planning is projection of workload in terms of facilities and personnel. I have stated that this need is elementary, but many laboratories are operated with very little effort applied to such planning. I have done so myself, and have greatly increased my problems by so doing.

The simplest component of workload projection is the plot of current long-term projects and average workload of short term projects based upon past experience. This is relatively precise data and accurate forecast of equipment loading and personnel requirements can be made with considerable assurance. When we get into the area of forecast of new projects or fluctuation of short term workload, the factors of management skill and foresight are dominant. In the case of the "typical" laboratory which I am using for a frame of reference, the foresight would, in most cases, be developed through close liaison with those activities of the Company who would be aware of projects that were pending or being proposed. The manager of this type of laboratory must make every effort to establish this channel if he intends to do an effective job of planning.

In the case of the Government Agency Environmental Laboratory, there is a more precise source of information, Due to the wide recognition of the planning function and to the budgeting requirement, the Laboratory Chief should have an excellent picture of future requirements over a period of several years. Of course, budgetary changes and the like can substantially affect his projection, but he has, at least, something to work with.

To the unbalanced individual who manages an Independent Commercial Laboratory, this problem is an extremely difficult and complex one, and one of the most critical factors in determining success or failure. He does not have a parent organization or higher command to determine what services will be required. He must look to all of Industry and all of the numerous Government Agencies and try to determine the amount of what kind of services will be required.

Once we have projected the future workload, we must then determine facility requirements. Determining the nature and extent of equipment required presents one of the problems peculiar to the field of Environmental Laboratory Management. I say that this is a particular problem because the environments to which our weapons systems are being subjected, both natural and induced, are changing so rapidly. In addition, our knowledge of the significance and effect of environments is improving steadily, resulting in a requirement for more sophisticated simulation equipment. Because of the relatively large capital investment required for this type of equipment, a considerable responsibility is placed upon the shoulders of the Environmental Laboratory Manager. In specifying new equipment, he must take into consideration the requirements of the future, as well as those of the present. But yet he cannot afford to be unrealistic and ask for the moon or he will not be able to justify the expenditure. Assuming that he has an alert and economy-minded management, the manager must have sound factual data, clearly indicating the probability of requirement for the simulator performance he is requesting.

Most of you are familiar with some of the evolutions in environmental requirements that have taken place in just the past few years. The rapid advancement in vibration frequency requirements, shock magnitude and temperature increase are some examples. Recognition and requirement for what may be considered new environments, such as random vibration, acoustic vibration and nuclear radiation are still evolving and have not yet reached us all. Another factor having a critical effect on the selection or specification of simulators is the interaction or combination of environments. This facet of our field is still in a somewhat embryonic stage and requires a great deal of research and development effort. But we should be prepared in so far as practicable.

Therefore, the Environmental Laboratory manager has a definite responsibility to keep informed of developments in the field. There are many sources of such information such as Trade Association working committees, Technical Society periodicals and working committees, etc. But one of the best sources of this awareness is in specific technical symposia.

Some other factors to consider are: size of chamber work space; weight range of products to be evaluated;

duplication or redundancy; percentage of utilization; maintainability. Careful consideration must be given to selection of the dimensions of the chamber work space. Of course, you must first determine the configuration of the largest object included in the majority of your work. I use the term "majority" because it is not economically feasible to design your requirement around a large object you would have only an occasional requirement to test. Once you have determined the configuration, you must consider the many testing specifications that require that the chamber be twice the volume of the product tested. Note, this is volume, not size.

Next is the factor of weight. This, again, should be determined by the majority of your projected requirement and should be considered in specification of "floor load" for chambers, as well as determining the load capacity for your shock, vibration and acceleration equipment. Another point that you should consider, if you are fortunate enough to have the information, is the location of the center of gravity of a good percentage of the products you will be called upon to evaluate. If you have a prevalently high C.G., make it known to your prospective simulator supplier, because the test specimen can take over the simulator if you are anywhere close to the machines capacity.

Of course, the quantity of your workload will be the primary factor in considering duplication of specific types of equipment. But one particular additional factor should be examined. Of the two principal components of a high-frequency vibration system, the power source or amplifier is usually much more costly than the exciter itself. Time studies have shown that nearly fifty percent of usable time is consumed in set-up. Therefore, by the addition of one exciter, you double actual vibration time available by switching the amplifier from one exciter to the other. Of course, the exciters must be matched.

One of the most harrowing sights to anyone who has had to really scratch and sweat for equipment is dust. If your forecast shows that you will have only occasional use for a piece of specialized equipment, such as explosion, sand and dust, etc., determine if you can obtain the use of this equipment elsewhere before you recommend buying it. The economy of capital is obvious, but, in addition, I am sure you will gain the respect of your management by taking this viewpoint.

One of the factors in selection or specification of simulators that is seldom given adequate consideration is maintainability. Many curses have been rained upon environmental simulators and their manufacturers, but not many people consider the fact that these poor things take more punishment than the products being tested, and, over a longer period of time. For this reason considerable emphasis should be put on quality, rather than on price, which is so often predominant. Examples of the type of things that should be considered are: the accessability of compressor seals on refrigeration systems, accessability of heaters which can burn out; replacability of seals on altitude chambers which can become defective and materials and drainage provisions on low temperature and humidity chambers. Another factor to consider is the relative merits of two-stage Freon 13 refrigeration systems and three-stage Freon 22 systems. The Freon 13 systems have some performance advantages, but Freon 13 is much more expensive than Freon 22, and if you develop a leak and lose a charge, it can be quite costly. Speaking of leaks, if someone advocates the use of iron pipe for a refrigerator system, question the reason. Copper tubing may be more expensive initially, but you will have nowhere near the leak problem you would have with iron pipe, primarily due to the difference between a welded joint and a sweated or soldered joint.

As many of you will note, I have covered only a few of the factors which should be considered in determining your equipment requirements and selecting or specifying your environmental simulators.
have accomplished my objective, if I have impressed upon you the necessity of careful consideration when discharging this responsibility.

Now that the subjects of organization, operation and facilities have been discussed, there remains the most vital problem of all - personnel. The most cleverly designed organizational structure, optimum control and procedures and the most sophisticated equipment are all of limited value unless you can staff the laboratory with adequate, qualified personnel.

The professional people required to most effectively operate an environmental laboratory should have certain characteristics in addition to their technical experience or qualifications. High on the list are imagination, flexibility, resiliancy and curiosity. The clod who has no interest other than to do the work assigned to him and go home at 5:00 P.M. and forget the whole thing will make your laboratory a dull, stagnant and practically useless place. The man who is interested in doing something in a better or more effective manner and wants to know what went wrong when something does, will enhance the respect for your laboratory by those whom you serve. The rapidly increasing recognition of the value of the environmental laboratory is primarily due to the performance of people with these characteristics who have provided more service and information than was asked for. It was not too long ago that the environmental laboratory was considered a necessary evil that existed only because of Government specification, and the only answer requested was, "did it or didn't it". But the request heard more and more often now is, "If it doesn't, can you tell us why and what to do about it". To enable your laboratory to answer this question, and to have it asked more frequently, you need people whose orientation is analysis. As these people accumulate, the experience of observing design or material selection (and most of the

mistakes made will be observed in your laboratory), it should not be too difficult to convince your organization of the valuable services the Environmental Laboratory can render.

Due to the rapidly increasing severity and significance of the factor of environment, the application of a bit of foresight would be appropriate. The alert research and development or design groups are more and more seeking the consultation of specialists who can advise them of the effects and interactions of environments as well as the selection of components and materials, at the research or design phase of a program, not after the prototype has been fabricated. In other words the trend is toward prediction and correction of the difficulty caused by environment before it occurs, not by the trial and error method after it is built. The academic world has not yet devoted much effort to training people who can provide this service, so if the Environmental Laboratory hopes to provide it, it must develop the knowledge. From my experience, most Environmental Laboratories are staffed almost exclusively with Engineers. I suggest that you now consider possibly the contribution of the other technical and scientific disciplines such as physics, physical chemistry and analytical chemistry. These disciplines are oriented more toward analysis than are the engineering fields, and can, with proper training and guidance, make a considerable contribution to the effectiveness of your laboratory.

Obviously a great deal more could be said on the qualifications, selection and training of personnel for an Environmental Laboratory, as well as most of the other subjects which I have discussed.

Therefore, what I have endeavored to do here was to merely expose, and briefly air, some of the major problem areas, in the hope that I could stimulate some serious thinking, and, perhaps, some activity. The field of Environmental Laboratory Management has some serious and unique problems that are increasing in significance as the science of Environmental Effects matures and expands. The preparation of this presentation has opened my eyes to a great need for more and better publications on the subjects of organization, control, administration, personnel, facilities, etc., as related to our field. I for one intend to devote considerable future effort to this problem and hope that some of you will as well. We all need the benefit of each others experience, which, after all, consists primarily of making mistakes and taking appropriate corrective action. But each of us cannot afford to make all of the mistakes. So let's help each other and those who will follow us by exchanging experiences and ideas in the field of Environmental Laboratory Management.

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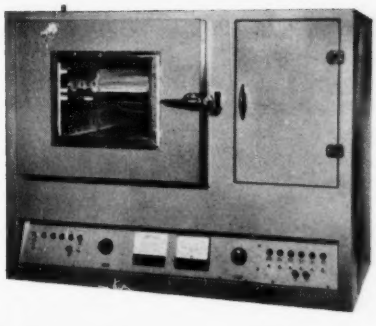

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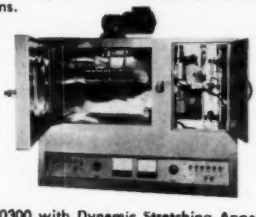

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NOTES FROM THE EDITOR

CHARLES W. DANIELSON
TECHNICAL EDITOR

The task of preparing a technical article for publication is difficult. A considerable amount of thought and effort goes into investigation and evaluation of the subject. Data related to the article must be obtained and checked for accuracy. Descriptions of the subject and test methods must be thorough and accurate. Charts, graphs, illustrations and formulas must be prepared to visually present the data.

However, although compiling of the contents is the most difficult task, presentation of the article in proper form is the most important. In order that the information in the article will be interesting and understandable to a wide variety of readers, it must be set forth in a clear, logical manner. To aid the writer, this issue of the JOURNAL contains a standard format which should be used in preparation of articles for publication.

GENERAL INFORMATION

Articles submitted to the JOURNAL for possible publication should be prepared in a standard engineering format. The desired order of the contents of the average article is as follows:

(1) TITLE
(2) AUTHOR'S NAME AND BUSINESS AFFILIATION
(a glossy, clear photo of the author is also acceptable)
(3) BODY OF THE ARTICLE
(4) APPENDICES
(5) ACKNOWLEDGMENTS
(6) BIBLIOGRAPHY
(7) TABLES
(8) CAPTIONS FOR ALL ILLUSTRATIONS
(9) PHOTOGRAPHS AND OTHER ILLUSTRATIONS
(including graphs,charts,diagrams, etc.)

Several of the categories are discussed briefly below.

BODY OF THE ARTICLE

The text of the article should be organized into logical parts or sections which will follow in an orderly manner. Care should be exercised to use simple terms and expressions. If highly technical or unusual terms or phraseology are used they should be adequately defined. The use of the first person and reference to individuals should be carefully worded so as to avoid showing personal bias. Company names should be mentioned only in acknowledgments.

As a general rule the text of an article should not exceed 3000 words. Illustrations and tables should be kept to a minimum. Company and government clearance should be obtained by the author, if necessary, and a separate sheet stating that such clearance or approval has been obtained should accompany the article. It is suggested that the author refrain from using or referring to classified material in his article.

All material such as charts, graphs, photographs, etc. must be reduced in size by the publisher, therefore, all such material should be made as simple as possible and show only that detail which is absolutely necessary. Lines should be made as dark and heavy as possible and all photographs should be clear and sharp and printed on glossy paper.

APPENDICES

It is often advisable in a highly mathematical article to develop equations and formulas in the appendix. Appendices may also be used for detailed descriptions of apparatus and other related material not essential to the general presentation.

TABLES
Tables of not more than a half dozen lines may be typed as part of the text, but they should be so located that they do not run over into another page. Larger tables should be typed on a separate sheet and assembled at the end of the article.

CAPTIONS
Captions for all illustrations should be typed on a separate sheet with the correct figure number preceeding each caption.

PHOTOGRAPHS
If photographs are included, the prints should be clear and sharp, with glossy finish. Photographs should be mailed flat between cardboards - not rolled or folded - and paper clips should not be used as they may mark the prints.

SUMMARY
It is the intent of the JOURNAL that all articles published should follow as uniform a pattern as possible. If the above procedure is adhered to it will make our task that much easier.

PICTURES NEEDED FOR USAF HANDBOOK OF THE ENVIRONMENT

A recent issue of this magazine reported progress on an environmental handbook being prepared on a contract for USAF at Wright Field. Institute members, selected for each section, have been reviewing material for this volume. In the course of the text review a serious shortage of photographic material has evidenced itself. This article constitutes an urgent appeal for photographs in the following categories:

a. *Environmental Factors and Effects*
Photographs showing the environment and/or damage are needed. Examples might be hail damage to an aircraft, a salt spray corroded relay, acoustic failures, etc.

b. *Environmental Protection*
Pictures or drawings of methods of overcoming environmental deterioration are desired.

c. *Environmental Test Facilities*
Photos of the more advanced environmental facilities are particularly desired, such as combined, hyper and space environmental facilities and instrumentation systems.

All prints should be 8 x 10 glossy black and white and should be accompanied by a release to use it in the handbook. Credit lines will be printed under each item used.

Please send all such photographs to:

Hq. WADD (WCLODC)
Attn: Mr. E. C. Theiss
W–PAFB, Ohio

THE REPRESENTATIVE'S ENVIRONMENT

ARCO ENGINEERING COMPANY REPRESENTATIVE TO U. S. GOV'T

Associated Testing Laboratories, Inc., manufacturer of environmental test equipment and environmental testing center for missile and aircraft components and systems, has appointed *ARCO Engineering Co.* of Washington, D. C. as its representative to the U. S. Government, announced *Bernard Novack*, Associated's vice president.

Fred Israel of ARCO will be the technical representative for Associated.

UNITED STATES TESTING APPOINTS WASHINGTON REPRESENTATIVE

The United States Testing Company, Inc., announced today the appointment of *Nat Kronstadt Associates*, 13107 Matey Road, Silver Spring, Maryland, as Engineering Representatives for the Washington, D. C. area.

In addition to handling the Company's government programs, *Nat Kronstadt* and his associate, *Murray Sparks*, will also serve the number of industrial accounts in the metropolitan D. C. area, trade associations, and many of the foreign purchasing agencies requiring testing and evaluation services.

Unholtz-Dickie Corporation has appointed manufacturer's representatives throughout the country for its line of vibration test systems and instruments. They are:

The Kennematt Co., Van Nuys, California; *Brooks Feeger Associates*, Albuquerque, New Mexico; *Remco Engineering Representative*, Seattle, Washington; *Space-Tronics, Inc.*, Mineola, Long Island; *C. E. Snow Co.*, Philadelphia, Pa., J. Y. *Schoonmaker Co. Inc.*, Dallas, Texas; *R. P. Kennedy Co.*, Rochester, N. Y.; *W. A. Brown Associates*, Indian River City, Florida; *S. Sterling Co.*, Detroit, Michigan.

LARGE FIXTURE UNEQUALIZED RESPONSE

Aluminum vs. Plywood

BY J.I. BACILE & W.J. REICH
AMERICAN BOSCH ARMA CORPORATION

The problem of fixture resonances which affect the levels of the vibration input to the item under test has received much of the Environmental Engineer's attention in the past. For sine wave testing in which the frequency band is scanned in a given length of time some "calibration" of the fixture is required. There are various techniques for accomplishing this. The important factor however, is that the "g" level at the shaker table surface is not the same as the "g" level on the fixture adjacent to the mounting point (or points) of the item under test. This discrepancy is due in large to the resonances of the fixture, and further, the larger and more complicated the fixture, the more pronounced the discrepancy. One of the methods used to minimize this difficulty is to monitor the acceleration ("g") level at a point on the fixture adjacent to a mounting point of the item and vary the amplitude control of the shaker as required during the frequency scan.

However, to perform a random vibration test this technique, and similar techniques employed in sine wave testing, can no longer be employed since frequency is not scanned at a given rate (i.e., frequency is no longer a function of time). Any combination of frequencies may be present at a given instant of time. This would call for different amplitude settings of the shaker simultaneously. Since this is impossible, the manufacturer has provided equalization networks which are intended to compensate for all resonances (mechanical and electrical) in the system.

This article is intended to show that resonances of relatively large fixtures complicate the problem of performing random vibration tests; that equalization for resonances is only a relatively easy and efficient process when the smaller fixtures and items are involved, and that the use of a material possessing relatively high damping properties for the construction of relatively large fixtures tends to alleviate the problems due to fixture resonance.

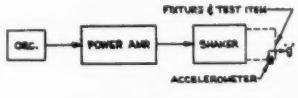

Fig. 1: Block diagram of components employed for obtaining the unequalized frequency response.

For continuity purposes, some background material will now be discussed. The general procedure for performing a random vibration test is to first obtain a plot of the overall transfer function g/E, where g is the acceleration level measured at the specimen mounting point and E is the oscillator voltage. Figure 1 shows a simplified block diagram of the components and signals employed.

This transfer function is sometimes called the unequalized response. Now this unequalized frequency response will not be flat over the entire frequency band (15–2000 cps). It will contain peaks and notches due to

(1) the electrical and mechanical resonances of the shaker equipment and (2) the mechanical resonances of the specimen and fixture.

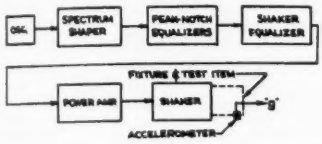

Fig. 2: Block diagram of components employed for performing equalization.

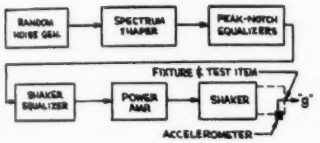

Fig. 3: Block diagram of components employed for performing random vibration test.

The next step in the equalization procedure is to electrically insert equalization networks which, when properly tuned, will compensate for the peaks and notches of the unequalized response. (Assuming for the moment that the test specification requires a flat acceleration density from 15–2000 cps). The exact manner in which this equalization is accomplished is beyond the scope of this paper. Figure 2 shows the block diagram of the components employed. Once equalization has been accomplished, the random noise generator is substituted for the oscillator, the proper cut-off filters are inserted and the test is performed. Figure 3 shows a block diagram of the components employed.

Attention will now be focused on the relative complexity of the unequalized response due to the specimen and fixture configuration. To show how this unequalized response becomes more complex with progressively larger and more complicated fixtures and specimens, some empirical results obtained will be discussed.

The simplest unequalized response possible is that obtained on the unloaded shaker. A typical plot of G/E for the unloaded shaker is shown in Figure 4a.

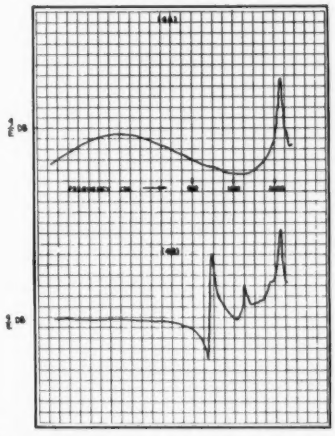

Fig. 4a: Unequalized response of unloaded shaker.

Fig. 4b: Unequalized response of shaker loaded with "simple" specimen and fixture.

This unequalized response is simple and presents no equalization difficulties. Equalization is accomplished with the shaker equalizer network. This is also the type of response obtained with extremely light and resonant free loads. For instance an aluminum block 3 inches by 3 inches by 3 inches with some transistors mounted on it.

Now, when a fixture and specimen are attached to the shaker of the order of 10 to 20 per cent of the weight of the moving element with one or two resonances between 15 and 2000 cps the unequalized response appears as shown in Figure 4b. An example of this type of table loading would be a welded aluminum right angle bracket type fixture containing a small to medium size transformer mounted on an electrodynamic shaker of 5000 pounds force rating.

This type of unequalized response again presents no equalization difficulties. However, consider attaching to the shaker the fixture and specimen shown in Figures 5a and 5b respectively.

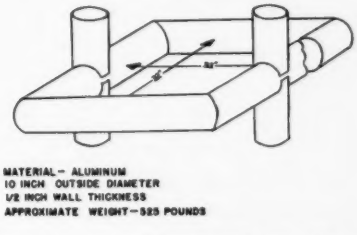

Fig. 5a: Aluminum Vibration Fixture for Item of Fig. 5b.

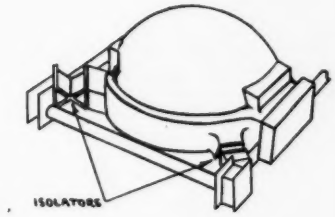

Fig. 5b: Test equipment Item.

The actual unequalized response is shown in Figure 6a. As can be seen from inspection of the figure, this response is exceedingly more complex than that for a simple (one or two resonances) fixture and specimen. In addition, since the specimen is mounted on vibration isolators (natural frequency of

system is less than 15 cps), the complexity of the unequalized response may be attributed in large to the fixture resonances.

This complicated type of unequalized response, which is not unusual for a fixture of the size and weight shown, presents a difficult equalization problem. As shown in the figure there are more than 30 peaks and notches. Therefore, at least the same number of peak-notch equalization networks are required for equalization, except in the special (and troublesome) case where the "Q" of the fixture resonance exceeds the maximum attainable "Q" of one equalization network. In this case "stacking" of the networks is required. Two or more equalization networks are tuned to the same frequency to compensate for the high "Q" of the fixture resonance. In addition, when the frequencies of the resonances of the fixture are so close to one another there is a considerable amount of interaction between the equalization networks such that as each network is added some (or all) of those already in the circuit require re-adjustment of frequency and Q. The most serious difficulty however, is the mismatch in the shape of the peaks and notches of the unequalized response and the transfer function of the peak-notch equalization networks. In many cases, especially at the higher frequencies, the "Q" and bandwidth of the peaks and notches of the unequalized response cannot be "matched" with the equalization networks. This situation leads to the introduction of new peaks and notches, the "Q" and bandwidth of which depends upon the degree of mismatch.

An ideal solution to the above difficulties would be to design an equalization network which could be adjusted in bandwidth for any given "Q" as opposed to a fixed band width for a given "Q". In addition, a minimum bandwidth of about 5 cps would be desirable. This added flexibility would allow the equalization networks to be matched quite closely to the peaks and notches of the unequalized response. At present unfortunately, this type of circuit presents some design difficulties for the frequency range of interest (audio range).

Another ideal solution to the problem would be to employ fixtures which are resonant free from zero to 2000 cps. In this case, only the shaker and specimen resonances would require equalization. However, it is only possible to fabricate a resonant free fixture (zero to 2000 cps) for the "smaller" test equipment items due to the weight limitations of the shaker equipment. For instance, assume for the moment that the equipment is rated at 5,000 pounds force rms, the item to be tested weighs 180 pounds and the test specification calls for an acceleration density of 0.05 g^2/cps from 15 to 2000 cps (flat). Performing the usual calculations it is seen that only about 220 pounds are available for the fixture. If the test equipment item is of any appreciable size, say 30 by 30 by 10 inches, it can be seen that to design a fixture which is resonant free to 2000 cps with the above weight limitation is no easy task.

Consider on the other hand building a fixture which produced fewer and broader (lower "Q" and wider bandwidth) resonances on an unequalized response. If this can be accomplished, the above difficulties would tend to be minimized. Fewer resonances would require fewer peak-notch equalization networks. In addition, the interaction between equalizers would be lessened thereby requiring less re-tuning. Lower "Q" resonances would eliminate "stacking" of equalizers and would also tend to eliminate the "sharp spikes", thereby minimizing the mismatch between the shape of the transfer function of the network equalizers and the unequalized response.

To build a fixture which exhibits the above characteristics which in turn will tend to minimize the complexity of the unequalized response, and at the same time introduce no new problems, was the problem to be solved.

Now in order to obtain a fixture which exhibits lower "Q" resonances some change in fabrication techniques and/or material was indicated. Specifically, a material which exhibits relatively high damping properties and good structural characteristics had to be chosen. A good comparison between the damping properties of materials

Continued on page 33

CO_2 AND N_2 COOLED CHAMBERS

BEMCO

DF-Series

Standard one cu. ft. chamber, DF-100/650-1 uses dry ice. This bench type is shown on a removeable stand Other accessories include liquid CO_2 cooling, vibration diaphragm, special ports and electrical fittings.

Designed for liquid N_2 cooling; this type of chamber is used for -320 F to +400 F vibration studies. The 24" diameter vibration diaphragm in the bottom and large access ports in front, back and lid provide maximum flexibility.

A typical + or - 1 F liquid CO_2 cooled -100 F to +700 F chamber with 95% ± 5% relative humidity control. Special ports, hydraulic fittings and automatic door are included.

Expendable refrigerants such as dry ice, liquid CO_2, N_2, and He_2 are very suitable for producing low temperatures for environmental and production work. Sublimation of dry ice within the chamber, chilling brine for circulation through coils, or direct expansion of liquid CO_2 or N_2 in the test space are some of the methods used with these expendable refrigerants.

Close control of temperature is usually accomplished by electric heaters which "buck" the refrigerant.

Dry ice and liquid CO_2 sublime or boil at a temperature of -109 F. Liquid N_2 boils at approximately -320 F while liquid He_2 boils at -452 F. The latter two gases are particularly useful for work beyond the range of mechanical refrigeration systems.

Advantages of these refrigerants include reduced initial cost, simplicity of equipment, reduced weight and size, and ability to produce very rapid pull-down to low temperatures. Elimination of the direct expansion refrigeration coils from within the chamber makes very high temperature work practical in these chambers.

Disadvantages include high operating cost per hour at low temperature, inconvenience of providing the expendable refrigerant supply and disadvantage of submerging the test in CO_2, N_2, or He_2 gas when these are expanded directly into the test space. Indirect brine systems approach the first cost of mechanical refrigeration systems. Direct expansion of expendable refrigerants in altitude chambers is impractical.

Bemco, Inc., develops, designs and manufactures a complete line of environmental equipment for simulating altitude, vacuum, pressure, temperature, humidity, salt spray, sand and dust, sunshine, rain, explosion and other conditions. Further details will be sent on request.

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100% automatically controlled CONRA

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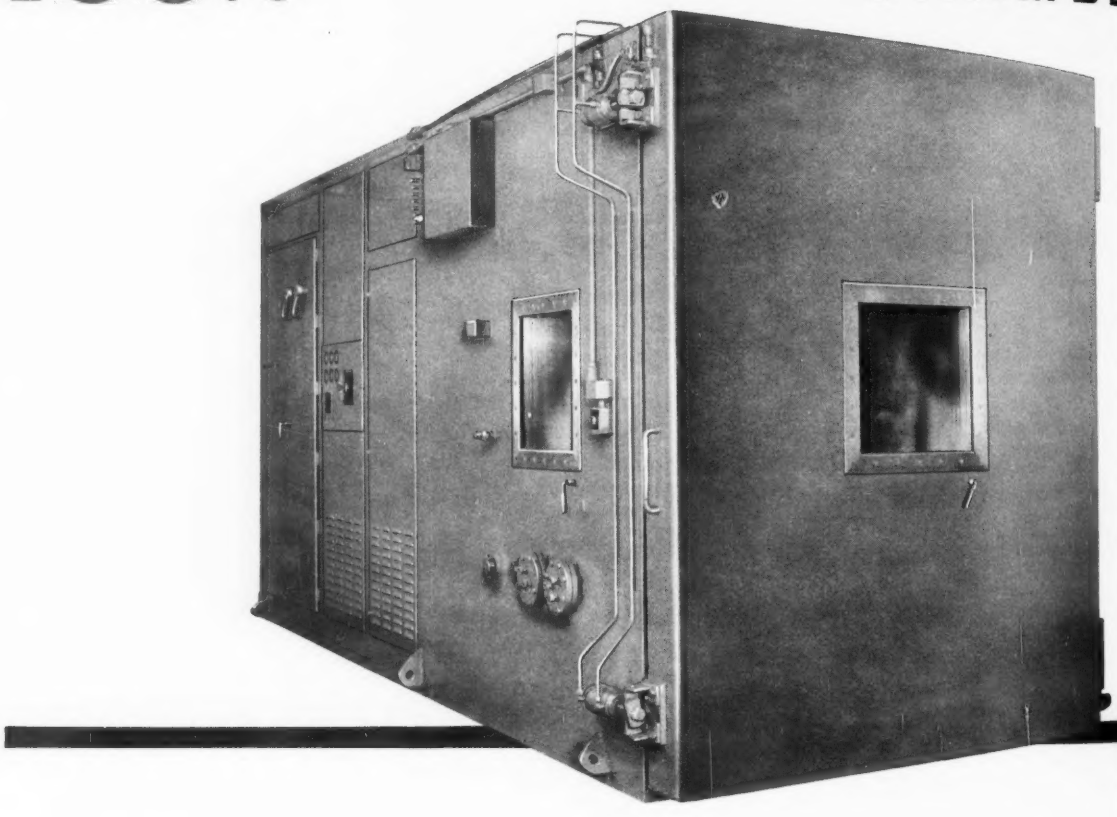

CONRAD Inc. MODEL WI 288-20-20

TEMPERATURE-HUMIDITY-ALTITUDE CHAMBER *with* CONSOLE

This chamber is supplied as a complete package unit, including all refrigeration, air supply, and vacuum system. It is designed to accommodate a large "shaker" for vibration testing of components in desired conditions of heat, cold, humidity, and altitude.

Size: 288 cu. ft.

Temperature Range: —100°F. to +500°F.

Humidity: 20% to 98%

Altitude: To 150,000 ft.

100% automatically programmed controlled.

Elaborate and versatile instrumentation of the Conrad chamber console includes running time meters, rate-timers, hold timers. Console has desk top, and storage space for test objects and special instruments.

BESPANS 0 TO 150,000 Ft. ALTITUDE IN 10 MINUTES

Conrad engineers put this 288-cu. ft. chamber through strenuous paces in testing it for the customer. The precision of Conrad design and manufacture were clearly evident throughout, but particularly in the chamber evacuation test. Starting at ambient, the chamber simulated an altitude of 150,000 ft. in 10 minutes. This is performance. And performance is why the customer—a prominent aircraft and missile components manufacturer on the east coast—*again* specified Conrad in equipping their new research facility.

Conrad's experience and recommendations are always available to help you determine your environmental test chamber needs. Telephone or write the representative nearest you for prompt service.

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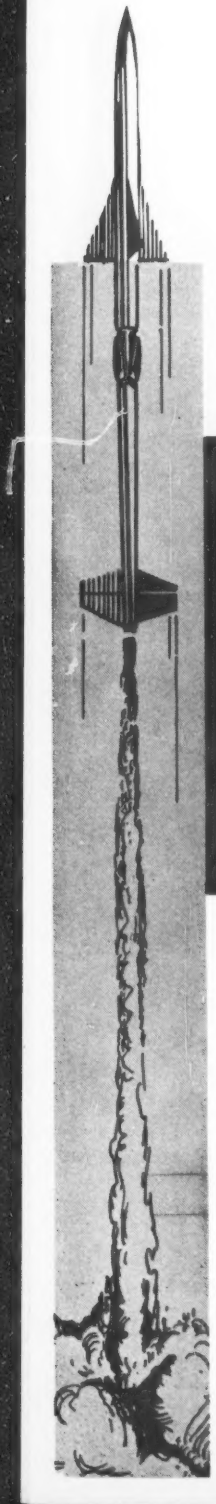
HOLLAND, MICHIGAN
A Subsidiary of Crampton Manufacturing Co., Grand Rapids, Michigan

flight testing on the ground

Environmental and Performance Testing for Quality Control, Reliability, and Qualification of Electrical, Electronic and Electro-Mechanical Components, Sub-Assemblies and Assemblies



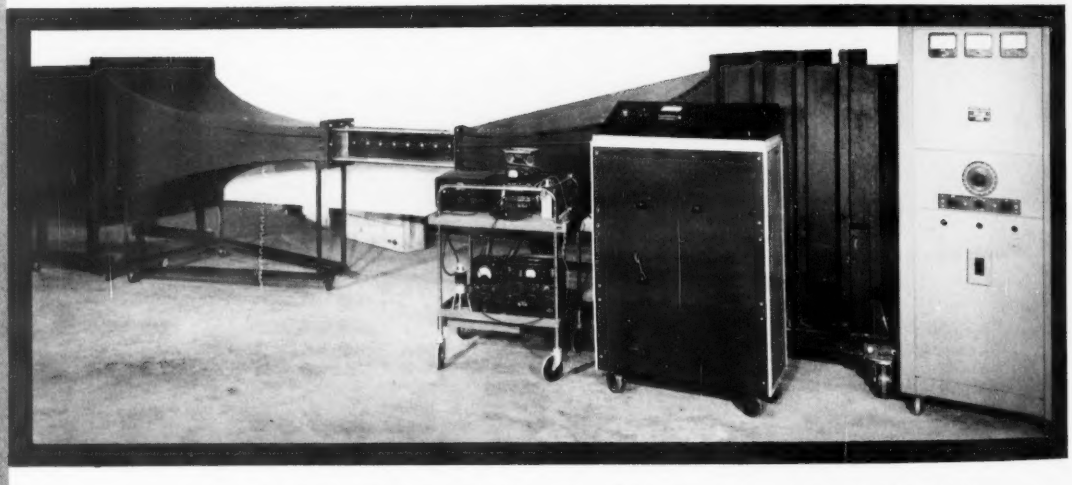
RANDOM NOISE ACOUSTICAL TESTING

Frequency spectrum: 75 cps to 10 K cps

Sound pressure level:

153 db (re: .0002 dynes/cm^2) in test chamber 5" x 5" x 16"
150 db in test chamber 8" x 8" x 40"
135 db in test chamber 40" x 40" x 40"

INTERMEDIATE SOUND PRESSURE LEVELS AND CHAMBER SIZES ALSO AVAILABLE



Acoustical vibration has recently been found--by the major airframe and missile manufacturers--to be an environment of prime importance in structures and electronic gear associated with jet and rocket engines. Rototest has developed and has operational a complete facility for testing components in high intensity sound vibration; much exceptional behavior has already been found in parts subjected to this environment.

Rototest is accepting requests for proposals to supply complete Acoustic Vibration test facilities.

ANOTHER ROTOTEST FIRST

CINE-RADIOGRAPHY: *Dynamic application of X-ray motion pictures to the study of behavior of electrical, electronic, electro-mechanical, hydraulic components, assemblies and sub-assemblies while under such environmental stresses as vibration and shock.*

rototest laboratories, inc. *2803 Los Flores Blvd., Lynwood, California*

NEW PRODUCTS

CEC FLUSH-MOUNTED STRAIN GAGE PRESSURE TRANSDUCER

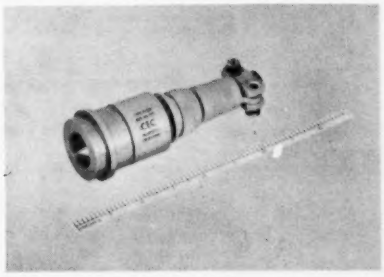
The Transducer Division of Consolidated Electrodynamics Corporation has added a flush-mounted pressure transducer with improved high-frequency performance to supplement its recently introduced "high performance" line of unbonded strain gage pressure transducers.

The new Type 4-327 is obtainable in pressure ranges from 0-100 to 5000 psi gage and absolute. Because the pressure sensitive diaphragm is flush-mounted, it can easily measure high-frequency transient phenomena.

Provision is made for adjustment of bridge balance, temperature compensation, and sensitivity external to the unbonded strain gage sensing element.

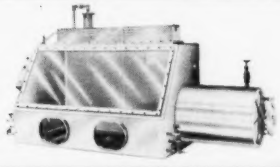
The Type 4-327 is designed for use where accuracy must be maintained under rugged environmental conditions, such as in missile test stands, aircraft and missile engine test cells, high-pressure pneumatic systems and nuclear reactors.

CONSOLIDATED ELECTRODYNAMICS CORP.
360 SIERRA MADRE VILLA
PASADENA, CALIF.



NEW DRY BOX HANDLES SENSITIVE CHEMICALS

Dry box recently developed by S. Blickman, Inc., 8400 Gregory Ave. Weehawken, N. J. allows the handling of sensitive chemicals and metals in a humidity-free atmosphere. Air from the Freon-tight main chamber is recirculated through a drying tower to provide a dew point of -75°F in 30 minutes or variations thereof. The airlock can be pumped down to approximately 50 microns with a mechanical pump; at this point, the leak rate will not exceed ½ micron per min.



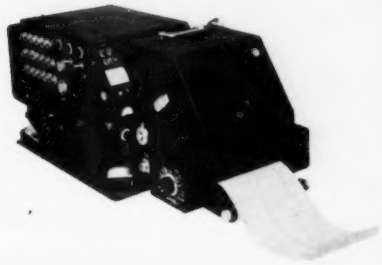
CEC INTRODUCES DATARITE MAGAZINE FOR TYPE 5-114 RECORDING OSCILLOGRAPH

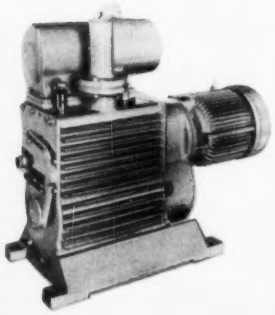
A rapid-access DATARITE oscillograph magazine has been introduced by the Electro Mechanical Instrument Division of Consolidated Electrodynamics Corp., Pasadena, Calif., for its Type 5-114 Recording Oscillograph.

The new DATARITE, designated Type 5-047, is interchangeable with the standard magazine, making possible a "quick look" at data from tests while they are in progress. The oscillograph comes in 18- and 26-channel models.

Fully developed, dry oscillograms are provided by the magazine in as little as 0.8 second after exposure. All processing is done inside the magazine from a single-solution developer. The process produces high-contrast, permanent records of data in the d-c to 5000 cps frequency range faster than any other oscillographic method.

Recording speeds are variable from 0.45 to 25 inches per second. The magazine holds a 400-foot roll of paper.





NEW CVC MECHANICAL VACUUM PUMPS

A complete new line of nine oil-sealed rotary mechanical vacuum pumps is now being offered by Consolidated Vacuum Corporation, subsidiary of Consolidated Electrodynamics Corporation, (formerly the Rochester Division).

Light and compact, these new CVC pumps are available in single-stage and double-stage models, produce lower ultimate pressures than pumps of comparable capacity, and have equivalent speeds. The rated capacities of the pumps range from 7 cfm to 106 cfm.

The loud clatter typically produced by mechanical pumps has been eliminated by the unique feature of an air valve suppression port, and by reduction of vibration through static and dynamic balance of the entire piston drive assembly.

Each of these new positive displacement pumps is equipped with a gas ballast to speed the evacuation of large volumes of water vapor. This gas ballast can be by-passed when water vapor conditions are not severe or when lower pressures are required. Ultimate pressure is 2×10^{-3} mm Hg or lower with the single-stage pumps, and 2×10^{-5} mm Hg or lower with the double-stage pumps.

Specifications are detailed in Bulletin 8-15, available from Consolidated Vacuum Corporation, Rochester 3, New York.

NEW LINE OF DRI-MARK SIGNS AND MARKINGS

The Meyercord Co., decalcomania manufacturer with main plant at Chicago, Illinois, announces the availability of a complete new line of DRI-MARK films. The DRI-MARK films are custom-processed Pressure Sensitive applied signs for use as durable truck signs, window signs, nameplates and product markings. In addition to DRI-MARK Decals, the DRI-MARK line includes these distinctly new products: DRI-MARK Vinyl, DRI-MARK Mirro-Cal (a chrome-bright mirrorized film), DRI-MARK Clear Mylar*, DRI-MARK Mirro-Cal VML (a mirrorized vinyl Mylar* laminate) and DRI-MARK Outdoor Paper.

DRI-MARK DECAL ★ DRI-MARK VINYL ★
DRI-MARK MIRRO-CAL ★ DRI-MARK CLEAR MYLAR* ★
DRI-MARK MIRRO-CAL VML ★ DRI-MARK OUTDOOR PAPER ★

Also announced by Meyercord is the fact that all Meyercord DRI-MARK Films are protected by Colorgard 70 - an exclusive Meyercord Laboratory developed clear top coat. This is stated to be the toughest, most durable coat yet produced for the decal and transferrable film industry.

The Meyercord Co., 5323 West Lake Street, Chicago 44, Illinois.

Mylar is a DuPont polyester film.

NEW CHAMBER BY CONRAD, INC.

New 27 cubic foot temperature altitude test chamber Model FH-27 features hydraulic action positive vacuum door locks. Strip chart recording controlling of temperature. Standard available ranges –100°F. to +300°F. or to +500°F. Cooling rates: to –70°F. in 38 minutes. Heating rates: from –70°F. to ambient in 14 minutes, ambient to +300°F. in 20 minutes and to +500°F. in 45 minutes.

Potentiometer electronic recording controller for altitude and temperature. A manometer control for altitude indication and vacuum throttle and bleed valves are included. A wide variety of terminal feedthrough attachments are available as well as through penetrations.

CONRAD, INC. 141 Jefferson St.
Holland, Michigan

COMPACT TRANSISTORIZED POWER SUPPLY

A well regulated dc power supply designed primarily for transistor circuit work and other applications where recurrent spikes and other transients would damage equipment under test is announced by Solidyne. Voltage and current meters are provided for accurate setting of output voltage and continuous monitoring of load currents. Voltage output is adjustable from 5 to 35 volts with a maximum current of 2 amperes. Either the positive or negative terminal may be grounded or the output can be floating. Regulation is better than 0.1% and variation in output voltage is never more than 30 millivolts. Ripple is held down to less than 1 millivolt.

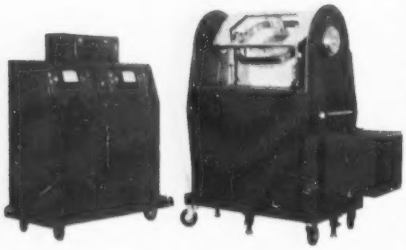
Model PS201 is approximately 14 pounds in weight and occupies less than a square foot of bench space. Protection against load short-circuit is provided by a fast circuit breaker with manual reset.

For further information write Solidyne, 7460 Girard Ave., La Jolla, California.

CO_2 CONTROL UNIT

An integrated control unit for low-temperature high-temperature chambers using liquid CO_2 for cooling has been introduced by the DEVELOPMENT ENGINEERING COMPANY, INC., 9 Cross Street, Norwalk, Connecticut. This is a new piece of equipment for Environmental Testing.

The Control Unit is designed for use on new chambers or on existing chambers where conversion to liquid CO_2 cooling is desired. It is in a gray hammertone case, 6" x 10" x 3½" deep, containing all the necessary equipment and wiring for cooling by liquid CO_2 and heating by electric control. Installation time is less than 10 minutes.



MICRO GEE FLIGHT SIMULATION TABLE MODEL 17A

Micro Gee announces the New Model 17A Two-Axis Flight Simulation Table which enables "flight testing" of complete missile or air-space craft stabilization and control systems on the ground, as contrasted to such programs where gyro and accelerometer dynamics are linearily simulated.

The Model 17A two-degrees-of-freedom table is also used for angularly displacing gyros and accelerometers, in pitch and roll, either statically or dynamically. The extremely smooth operation, due to specially designed, driven pendulum mechanisms, also enables use of the table as an oscillating table to determine the threshold characteristics of high performance gyros and accelerometers.

Features of the table include extended angular travel over prior models and the ability to handle a 25-pound load. The natural frequency of each axis is in excess of 15 cycles/sec. Adjustable damping is provided and the threshold of each axis is less than .005 degrees.

The table will follow signals such as those from an analog computer, a low frequency function generator, a tape recorder, or a digital-to-analog converter.

Manufactured by Micro Gee Products, Inc. - P.O. Box 1005 - 6319 West Slauson Avenue - Culver City, California.

ENVIRONMENTAL CHAMBERS FOR WIRE TESTING

A complete line of environmental chambers especially designed for testing wire and insulation breakdown, in accordance with military specifications, is available from CINCINNATI SUB ZERO PRODUCTS.

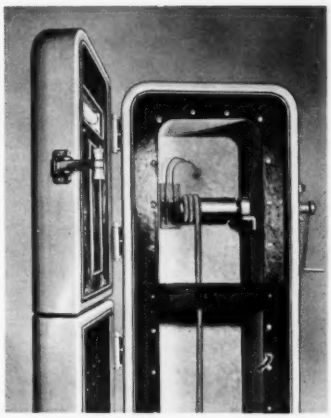
The chambers are constructed so that a mandrel can be installed in the upper part of the chamber. One end of the wire to be tested is suspended from the mandrel, with the other end hanging free. A specified weight is attached to the free end to exert a force on the wire.

By means of an outside control, the wire is wound on the mandrel without disturbing the test temperature. After winding, the sample is removed and examined for surface cracking and other flaws. This "cold bend" test is used for improving many types of commercial and military wire.

The one-piece cabinet is constructed of 16-gauge steel with a 10-gauge steel base for extra strength. Outside dimensions are 84" high, 20" wide and 42" deep. The testing chamber, constructed of 14-gauge galvanized steel, measures 12" x 12" x 72".

The chamber is lighted, has a Multipane frostproof window 6" wide x 12" high, and is available with or without a circulator to keep inside air recirculating at all times to prevent stratification of warm air. The unit operates on 230 Volts and has a temperature adjustment from –10 to –80°F. Thermal capacity is 200 BTU/hr at –70°F. Other capacities and temperature ranges are available.

CINCINNATI SUB ZERO PRODUCTS, 3932 Reading Road, Cincinnati 29, Ohio.



NEW, VARIABLE TEMPERATURE BATH

A new variable temperature bath - called Producttemp Bath - for testing diodes, electronic components, thermostats and other parts which are subjected to rigid test conditions. Just introduced by Labline, Inc., manufacturers of laboratory instruments, apparatus, equipment, 3070-82 West Grand Ave., Chicago 22, Illinois.

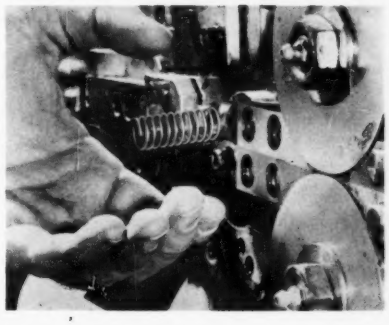
INTRODUCE SPRING WIRE FOR OPERATING TEMPERATURES TO 1400°F

A precipitation-hardened super-alloy cobalt wire has been introduced by National-Standard Company for forming springs to operate at ambient temperatures from 400° to 1400°F. Designated Alloy HS 25 or No. L-605, the spring wire is made principally of these metals: cobalt (46 to 53%), chromium (19 to 21%), tungsten (14 to 16%), nickel (9 to 11%), and carbon (.05 to .15%).

The wire is available annealed to 35% reduction. Wire drawn to 30% reduction, a typical reduction, is available from 0.171–to 0.018–inch diameter. Tensiles for the 30% reduction range from 200,000 to 240,000 psi, depending on wire diameter. Elongation ranges from 4 to 8% for the 30% reduction.

HS 25 is supplied for automatic coiling with a gray oxide finish that can be removed by nitric acid, tumbling, vapor blasting or similar methods.

Before drawing, rods are welded together with magnetic stainless steel. Since HS 25 is nonmagnetic, welds in finished springs can be identified with a magnet.

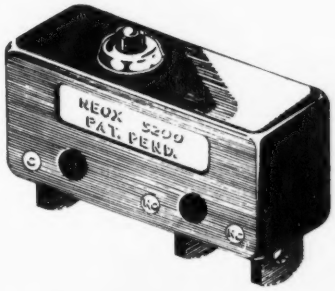


100G SNAP ACTION SWITCH

A newly designed Snap Action Switch soon to be available in several different styles and ratings, possesses characteristics far exceeding previously available types.

A solid conducting leaf supported on pivots at each end maintains the switch contact pressure very high even under severe shock and vibration conditions. The pivots and low metal stress levels allow long mechanical life. The lack of cutouts in the leaf together with large contacts and efficient heat conduction paths increase switch's ratings.

The very high mechanical efficiency of the switching mechanism affords contact pressure almost equal to plunger pressures. In addition, speed of switching is fast enough to reduce contact arching and allow fast operation of the actuating mechanism.



First models available are designed for operation in environments of 100G's to 3000 CPS with no contact bounce; current ratings of 7 amperes, 28 VDC resistive; operating temperature ranges from –65°F to 350°F. Excluding plunger and terminals, the case dimensions are 0.250" x 0.440" x 0.781". The outline dimensions and mounting provisions are in accordance with Military Specifications. THERMOCAL, A Division of Jamieson Laboratories, Inc., 1631 Colorado Avenue, Santa Monica, California, will have production quantities available before March 1, 1960.

The technical program for the Institute of Environmental Sciences' 1960 national meeting promises to be the most comprehensive covering space environments ever held in this country. Under the theme "Hyper-environments...Space Frontier", scientists and engineers from coast to coast will converge at the Biltmore Hotel in Los Angeles April 6, 7, & 8 for three intensive days of discussions. In parallel sessions, latest information in the equipment and life environmental sciences will be exchanged. At the same time, a major equipment exhibition has been planned where manufacturers and research laboratories can show the results of their concentrated effort to produce reliable materiel, advanced testing apparatus, and to develop unique skills to meet the challenge of the "Space Age". Only products or skills which are closely aligned with the environmental sciences may be shown. Exhibits have been carefully screened so that attendees will be able to enjoy a tour where nearly every booth is of direct interest.

The forthcoming meeting represents the first major effort of the "Institute of Environmental Sciences" to be sponsored on a national scale. There will be many other "firsts". This year marks the first meeting where the "Proceedings" will be available for distribution to registrants. Furthermore, some papers will be on sale at modest cost, both individually and in quantity, during and after the national meeting. To stimulate audience participation, and derive maximum benefit from the discussion following a paper, a brief commentary on the paper will be prepared in advance by a leading authority, to be read immediately after the author's presentation. Sufficient time will be reserved for the ensuing discussion to minimize premature cut-off, in most cases. Practically every paper has been written with a tone that invites free discussion of the author's topic...and discussion will be encouraged.

The three-day conference will carry three parallel sessions throughout. Separate meetings will be sponsored for those persons interested in life sciences and the environments, apart from those being carried in materiel. By means of these three sessions, as many as 21 papers a day will be presented. On the first day, all sessions will center attention on describing the hyper-environments and the possible effects to be encountered in these environments. During the second day, attention will be given to designing against the hazards posed by the environments, whereas the third day will largely find papers treating problems in proof-testing, test requirements, reliability programs, and the like. Thus it should be possible to acquire a balanced viewpoint in the major areas of research and development which comprise the environment technology, simply by attending sessions all three days.

Typical examples of the excellent papers that can be expected are:

The Solar Wind as a Hyper-environmental Parameter by T. A. Bergstralh, L. J. Kieffer & I. H. Blifford, Aeronutronic Div., Ford Motor Company

Space Radiation as an Environmental Constituent by R. F. Badertscher, & R. E. Hess, Battelle Memorial Institute

Lunar Temperature Environment by J. C. Grafton & J. A. Stevenson, Missile Division, North American Aviation, Inc.

Nuclear Rocket Environment by A. H. Flagg, B. Mandell & L. E. White Aerojet-General Corporation, General Tire & Rubber Corp.

Thermal Environment of Electronic Equipment in Space Vehicles by N. E. Wood, Douglas Aircraft Company, Santa Monica Division

The Effect of Micrometeorites on Reflecting Surfaces by R. E. Henderson, Allison Division, General Motors Corp., & Paul Stanley, Prof. of Aeronautical Engineering, Purdue University

In the Life Sciences:

Radiation Shielding Problems in a Manned Space Flight by L. E. Wallner & H. R. Kaufman, NASA Lewis

Continued on page 31

THE PRESIDENT'S CORNER

This month I would like to depart slightly from past precedent and discuss with you a problem which is common to the field of Environmental Science and Reliability, rather than anything specific about the Institute. I refer to the lack of coordination and interchange of information between the fields of Environmental Engineering and Reliability Engineering.

First, let us look at the history of Environmental Science. The first major effort in Environmental Science was during World War II. The reason for the upsurge at this time was tied directly to the reliability of equipment under severe environmental conditions. In brief, they didn't work. Subsequently, the field developed to the point where it is today - a well-founded, scientific field.

Reliability, on the other hand, did not come into its own until the missile age. Due to the complexity of a guided missile and the lack of a human being to "patch up" a malfunction, the problem of reliability was brought tremendously to the forefront. It is emphatically stated by the Department of Defense that Reliability is one of our major problems in the production of complex systems. But here again, environmental conditions are closely linked with reliability problems, since the majority of failures occur when the missile is subjected to its use environment.

And yet, the fields of Environmental Science and Reliability Engineering seem to stand apart, separated, I feel, more by an artificial boundary than any real differences. In the performance of any reliability test much more use must be made of *realistic* environmental conditions than has been done in the past. Similarly, in an environmental test much more use must be made of statistical design of the experiment than has been done in the past.

Since most human beings tend to look with suspicion on the combination of their group with another group, it is understandable that the Reliability and Environmental groups in many, if not most, companies, stand apart. Each strives mightily toward his own goal and strives equally to ignore the existance of the other group.

A similar thing occurs in the technical societies. Although there is no Reliability Engineering Society, each of the several other technical societies have sub-groups devoted to reliability and the intercourse between these sub-groups and the I.E.S. is at present practically nonexistant. It is my personal feeling that the I.E.S. should strive to bring about a much stronger bond between Reliability Engineering and Environmental Engineering.

I realize that this is a somewhat controversial subject and I should like to hear the feelings of you, the readers, on this matter so that in the next issue of the Journal we can publish other opinions and viewpoints on this subject, which I feel is of utmost importance to the defense of our country.

TECHNICAL INFORMATION

APPLIED RESEARCH LABS

Flexonics Research Laboratories has available a 19 page Capabilities Summary to acquaint engineers and companies with our test facilities and types of service we are prepared to render. Our capabilities lie in applied research, product development and testing in the fields of hydraulics, pneumatics, metallurgy, physical and climatic environments and structural dynamics.

Flexonics Research Laboratories
840 North State Street
Elgin, Illinois

NEW FASTNER GUIDE

Elastic Stop Nut Corporation of America introduces a new ESNA 80-page fastner guide for spacecraft, missile and power plant engineers with high temperature assembly problems.

This new catalog includes a resume of technical data pertaining to high temperature terminology, fastners to use for high temperature applications, general production and design data as well as other interesting and important information.

For your copy of Catalog No. 5918 write to:

Elastic Stop Nut Corporation
of America
Dept. S41-1225
Union, New Jersey

ROOTS HIGH VACUUM PUMPS

Consolidated Vacuum Corporation announces their new brochure containing valuable information and technical data on the Roots Principle and Roots Pumps now available.

Ask for Bulletin No. 8-20 from:
Consolidated Vacuum Corporation
1775 Mt. Read Blvd.
Rochester 3, New York

VIBRATION TEST SYSTEMS

Unholtz-Dickie Corporation offers new bulletin describing Series 70 Vibration Test Systems. Four page bulletin. System performance, components and accessories are covered. A complete description and dimensions of the 400 lb. force shaker is given as well as the control console. Request Bulletin No. 59-5.

Unholtz-Dickie Corporation
2994 Whitney Avenue
Hamden 18, Connecticut

BROCHURE ON ULTRA-TEMP. OVENS

Informative four-page, two-color brochure on special line of Blue M Equipment headed Blue M Ultra-temp Ovens.

Attention herein directed to units such as Blue M Recirculating Ovens, Miniature Batch Ovens, Mechanical Convection Ovens, and entire Blue M Ultra-Temp Series.

Ideal for applications requiring temperatures to 1300° F.; capacities from one (1) cubic foot to thirty-six (36) cubic feet as well as those for Air Force Specification MIL H-6088A and others.

For free Bulletin No. 6950 write to:
Blue M Electric Company
138th and Chatham Street
Blue Island, Illinois

NEW CATALOG ISSUED BY ASSOCIATED TESTING LABORATORIES, INC.

Caldwell, New Jersey, December 18, 1959 -- A new two-page, two-color short-form catalog that describes and illustrates thirteen different types of environmental test equipment is available from Associated Testing Laboratories, Inc., Manufacturing Division, Clinton Road, Caldwell, New Jersey.

Among the test equipment featured are an acoustic-noise test system, auxiliary vibration (slippery) tables, and saw-tooth shock machines, as well as Associated's large line of environmental test chambers.

CEC/RECORDINGS

The Fall 1959 Issue of CEC/Recordings is now off the press. This beautifully illustrated 23-page quarterly contains technical articles on subjects such as *"Flight Testing at Mach 2"*, *"Before The Countdown"*, *"Vacuum in Volume"*, *"Menace of The Silent Noise"*, and other informative articles.

Available from:
Consolidated Electrodynamics
Corp.
Paul N. Bertness, Editor
360 Sierra Madre Villa
Pasadena, California

THE RIGHT ANGLE

The November Issue of *The Right Angle* is now available. Published by The Industrial Division of Sanborn Company, Waltham 54, Mass., *The Right Angle* is a source of helpful technical information for users and potential users of Sanborn Oscillographic Recording Equipment.

TECHNICAL INFORMATION

TENNEY PUBLISHES BROCHURE ON WALK-IN SPACE CHAMBERS

A brochure describing features and capabilities of walk-in space chambers and picturing many applications is available from Tenney Engineering, Inc., a major producer of environmental test units.

The huge chambers include a variety of specifications for the simulation of extreme conditions of space, such as altitudes to 1.5 million feet, temperature from -150° to +2000° F., humidity to 95 per cent, rainfall to 24 inches per hour, ram air flow, varied altitude climb and dive rates, solar radiation to 140 watts per square foot, radiant heat assemblies, dissipation of live or static loads and vibration accommodation.

Copies of the two-color brochure may be obtained from Robert H. Brown, Vice President-Sales, Tenney Engineering, Inc., 1090 Springfield Road, Union, N. J.

RECORDING OSCILLOGRAPH

CEC's Type 5-114 Recording Oscillograph is the subject of an illustrated 16-page brochure published by the Electro Mechanical Instrument Division of Consolidated Electrodynamics Corporation.

Subjects covered include evaluation by dynamic testing, a complete description of the 18- or 26-channel oscillograph, specifications and features, a description of the DATARITE rapid-access magazine and other accessories, and a table of specifications for CEC galvanometers.

Copies of bulletin 1500 are available from CEC at 360 Sierra Madre Villa, Pasadena, California.

ELECTRONIC SPEED CONTROL EXCLUSIVELY ON RUCKER SMALL CENTRIFUGES

The new electronic speed control circuit—an exclusive feature on Rucker Series I Centrifuges, provides: Digital Control Setting: Only one setting required to reach any desired speed • Programmed Sequence or Remote Operation • G Rating Repeatability • Dependable, Quiet Operation • Fast Test Cycle • Automatic or Programmed Dynamic Braking

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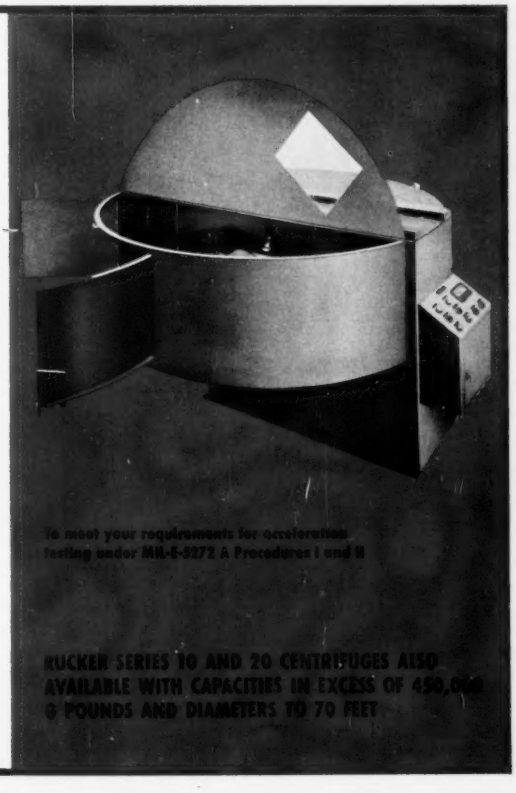
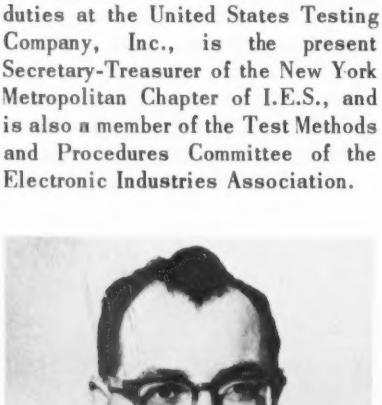

To meet your requirements for acceleration testing under MIL-E-5272 A Procedures I and II
RUCKER SERIES 10 AND 20 CENTRIFUGES ALSO AVAILABLE WITH CAPACITIES IN EXCESS OF 450,000 G POUNDS AND DIAMETERS TO 70 FEET

names and faces

R. F. HAHN SPEAKS AT INSTITUTE OF ENVIRONMENTAL SCIENCES SYMPOSIUM, NEW YORK

R. F. Hahn, Manager, Engineering Department, United States Testing Company, Inc., today addressed the Second Annual Technical Symposium and Product Exhibition, "Instrumentation For The Environment," New York Metropolitan Chapter, Institute of Environmental Sciences. Mr. Hahn's paper, "Digital Techniques In A Component Evaluation Laboratory," was presented in the session on *Digital Techniques and Automation.*

Mr. Hahn, in addition to his duties at the United States Testing Company, Inc., is the present Secretary-Treasurer of the New York Metropolitan Chapter of I.E.S., and is also a member of the Test Methods and Procedures Committee of the Electronic Industries Association.



NAPOLITAN NAMED GENERAL MANAGER OF NATIONAL ELECTRONICS CONFERENCE

Chicago -- Rudolph J. Napolitan has been named general manager of the National Electronics Conference, announced Virgil H. Disney, NEC president.

Mr. Napolitan was formerly general sales manager of A.R.F. Products, Inc., and assistant general sales manager of Permoflux Corporation.

The National Electronics Conference is an international forum held annually in Chicago to report latest progress in electronics research, development and application. Its technical sessions and exhibits are attended by over 10,000 engineers, educators and executives representing industry, universities and government.

SID SHAPIRO IS APPOINTED VICE PRESIDENT OF TENNEY

Sid Shapiro, of Westfield, N.J., has been promoted to vice president of Tenney Engineering, Inc., as head of the company's expanded heat transfer components division, Monroe Seligman, president announced. Tenney's home office, where Mr. Shapiro makes his headquarters, is in Union, N. J.

Mr. Shapiro is an associate member of the American Society of Refrigeration Engineers and a member of the Garden State Chapter of the Refrigeration Service Engineers Society.

MB EXPANDS FIELD SERVICE NETWORK

New Haven, Conn. -- Expansion of MB field service, with the opening of an additional office in Chicago, has been announced by George H. Mettler, President, MB Electronics. The company, a Division of Textron Electronics, Inc., now maintains fully staffed field service offices in Los Angeles and New York, in addition to the newly opened office in Chicago.

Mr. Mettler announced that Wayne Tustin has been appointed manager of field service and technical training for MB.

Regional field service manager appointments are: James R. Capelli, manager of the Eastern Field Service Office, New Haven; Joseph A. Silvestro, manager, Midwestern Field Service Office, Chicago; and Dennis C. Lynch, manager, Western Field Service Office, Los Angeles.

GUNNARSON APPOINTED GENERAL MANAGER OF MB ELECTRONICS

New Haven, Conn. -- The appointment of John A. Gunnarson as general manager, MB Electronics, has been announced by George H. Mettler, company president.

In this newly created position, Mr. Gunnarson will be responsible for overall operation and management of the company's two plants located here, which employ approximately 800

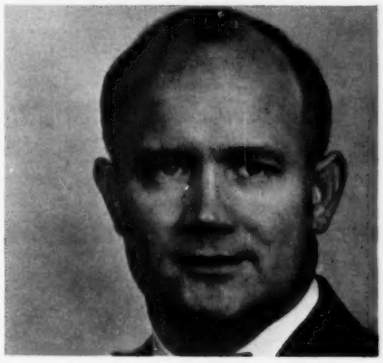
Prior to this new appointment he was general manager of the company's Vibration Division, located at 781 Whalley Avenue. He joined MB's industrial engineering department in 1951 following work with Westinghouse Electric International Company.

TRAGER NAMED DISTRIBUTION MANAGER FOR PURE CARBONIC

S. C. Trager has been appointed manager of the Pure Carbonic Company's distribution department, it was announced by J. J. Lincoln, Jr., president of Pureco. The appointment is effective beginning December 1, 1959.

Mr. Trager has been associated with the Pure Carbonic Company since 1951. He has held positions as assistant plant superintendent of Pureco's carbon dioxide plants in Kansas City, Kansas, and plant superintendent of its Deepwater, New Jersey, facility. At the Deepwater location he was also plant superintendent of Air Reduction Sales Company's nitrogen plant.

Most recently, Mr. Trager has served as assistant to the vice-president - distribution, in Pureco's New York headquarters.



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Flight Research Center, Cleveland

Confined Space Feeding by A. C. Avery, U. S. Naval Supply R & D Facility, Food Science & Engineering Division

The Ability to Apply Forces While Tractionless by E. Dzendolet, Aero-Space Medical Laboratory, Wright Air Development Division

Performing Man-Sized Tasks in Space by S. N. Roscoe, Hughes Aircraft Company, Culver City

A space Flight Escape System by W. Bishop & E. A. Schumacher, The Martin Company, Space Flight Division, Baltimore

Bio-Magnetic Phenomena by H. S. Alexander, Missile Division, North American Aviation, Inc.

Examples of papers which describe the design problems associated with hyper-environments are:

Magnetic Cores and Permanent Magnets in Hyper-Environments by D. I. Gordon, U. S. Naval Ordnance Laboratory, White Oak

The Suitability of Fiberglas Reinforced Plastic in Thermo-Acoustic Environments by J. M. Baskin, North American Aviation, Inc., Columbus

Turbo-Electric Power Generating Systems for Space by J. May, Sundstrand Turbo Division, Pacoima

Waste Heat Radiation in a Space Environment P. E. Kueser, Westinghouse Electric Corp., Small Motor Division, Lima, Ohio

Finally, the greatest proportion of papers offered treat the proof-testing and reliability programs designed to uncover environmental weaknesses. Some Examples:

Nuclear Environmental Testing by L. B. Gardner, Litton Industries, Incorporated, Beverly Hills

A Comprehensive Method for Evaluating Performance of Missile Radar Under Environmental Stress by S. G. Hibben, Harold C. Jones, J. T. Turner & Hugh C. Jones, Westinghouse Air Arm Division

Proof Testing By Assessing the Effect of Environmental Sequences W. R. Kuzmin, Packard-Bell Electronics Corp.

A New Random Vibration Test G. B. Booth MB Electronics, Inc.

A New Approach to Simulation of Solar Radiation by D. Askin & J. Wiland, U. S. Army Ordnance, Frankford Arsenal

Fixture Resonance Effects on Shock Response W. J. Reich, Arma Division, American Bosch-Arma Corporation

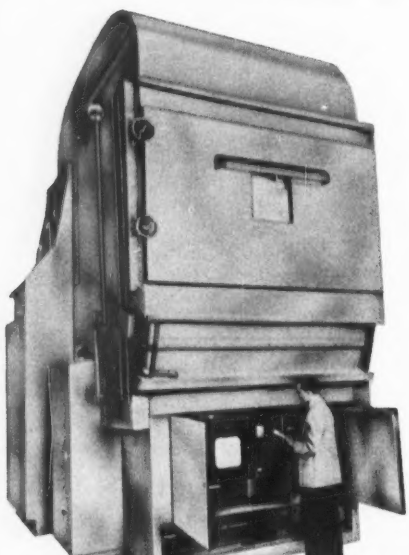
A Combined Environmental Testing Program for Increasing Atlas Missile Reliability by C. C. Campbell, Convair Astronautics Div.

Environmental Specification for the "Able" Series of Space Vehicles by S. C. Morrison, Space Technology Laboratories, Inc.

Environmental Testing of Mechanical Components at Elevated Temperatures by M. L. Headman & R. H. Tomren, Western Gear Corp.

Neal Granick, Chairman
Technical Program Committee

THE MOST ADVANCED TESTING TECHNIQUES ARE BEING BUILT INTO AMERICAN RESEARCH EQUIPMENT RIGHT NOW!



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Altitude, Temperature Humidity walk-in chamber 10′ high x 8′ wide x 12′ deep interior with push-button door controls inside and out.

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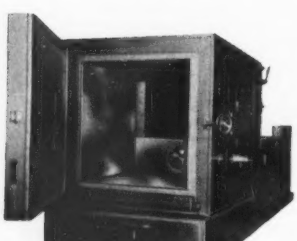

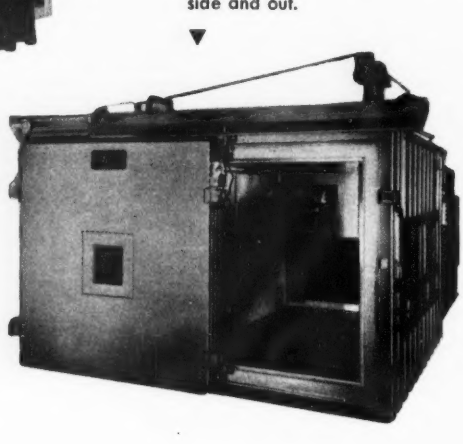

▲ Altitude chambers in any size—Altitude 200,000′ or higher; temperature +500°F and higher to −100°F and lower: Humidity 20% to 95%.

Designers and manufacturers of Altitude, Temperature, Humidity, Sand & Dust, Rain & Sunshine, Explosion, Special Liquid Chilling and other types of Environmental Test Equipment.

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Computing Devices of Canada Ltd., P.O. Box 508, Ottawa 4, Ontario Canada

Maher Engineering Co., 4335 West Peterson, Chicago, Ill.

COMING EVENTS

Feb 16-18-First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Hilton Hotel, San Antonio, Tex. Sponsors: Southwest Section, Society for Nondestructive Testing; Southwest Research Institute.

Feb 18-19-Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia, Pa. Sponsor: American Institute of Electrical Engineers' Basic Sciences Committee.

Mar 9-11-Conference on the Mechanical Properties of Engineering Ceramics, North Carolina State College, Raleigh, N. C. Sponsors: North Carolina State College School of Engineering; Office of Ordnance Research, U.S. Army.

Mar. 23-25-Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation.

Apr. 5-8-1960 National Aeronautic Meeting and Missiles and Aircraft Engineering Display, Society of Automotive Engineers, Commodore Hotel, New York, N.Y.

Apr. 6-8-Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8-1960 National Meeting "Hyper-Environments------Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

Apr. 20-22-National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: NASA; The Rand Corp.

Apr. 27-28-National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio

Continued from page 18

may be made through the use of the logarithmic decrement.[1] The logarithmic decrement for Cold Rolled Aluminum is about 0.0034, and for Hard Wood about 0.023 (one order of magnitude higher). The structural properties of wood are not as good as aluminum. However, large plywood fixtures had been used in the past for sine wave vibration testing without introducing any structural problems. Plywood was chosen as the material to be used since it seemed to fulfill the requirements of relatively high damping properties and reasonable structural properties.

In order to directly evaluate the advantages of this wooden fixture, the basic design was similar to the aluminum fixture shown in Figure 5a. In addition, the wooden fixture was designed for the same item (see Figure 5b). The details of construction, dimensions, and weight are shown in Figure 7. Only standard wood fabrication techniques were used. A concomitant advantage of using wood is low overall cost.

The unequalized response for this wooden fixture is shown in Figure 6b.

1 Mechanical Vibrations, Den Hartog, McGraw Hill 3rd Edition p. 54.

A comparison of the unequalized response for the Aluminum and Wood Fixtures (Figures 6a and 6b) yields the following conclusions:

(1) The wooden fixture response has less than half the peaks and notches of the aluminum fixture response (fewer resonances).

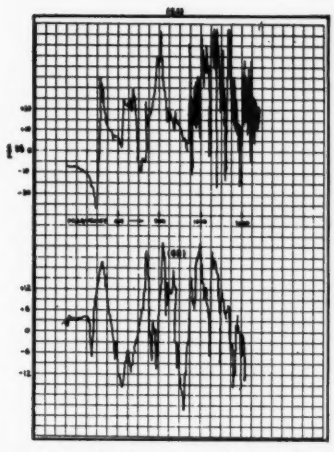

Fig. 6a: Unequalized response of shaker loaded with aluminum fixture of figure 5a and item of Fig. 5b.

Fig. 6b: Unequalized response of shaker loaded with wooden fixture of Fig. 7 and item of Fig. 5b.

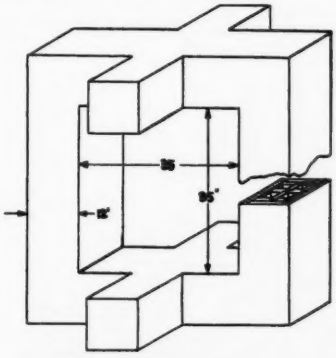

Fig. 7: Wooded fixture for item of Fig. 5b.

(2) The peaks of the aluminum fixture response range from –25db to +60db while the peaks of the wooden fixture response range from –24db to +24db (lower "Q").

(3) The bandwidth of the peaks and notches of the wooden response are in general broader than those of the aluminum response thereby tending to minimize the sharp spikes which are the main source of the mismatch between the equalizer networks and the response.

Although the complexity of the unequalized response has been reduced there is still something to be desired in the shape of the response curve since it still does not conform to the transfer function of a peak notch equalization network. There are still a few "sharp spikes" and unsymmetrical portions on the unequalized response curve. This will present some difficulty during the equalization procedure.

The question of "fixture life" or structural durability cannot be answered fully at this time. However, the wooden fixture discussed above has already been subjected to fifty hours actual vibration time. There has been no evidence of structural deterioration to date.

Based on the above results, the use of a material which has relatively good damping properties for the construction of relatively large fixtures for random vibration testing over wide frequency bands seem promising.

Additional work with different materials for the "larger" fixtures, fabrication techniques, and basic design is certainly indicated. Also, as stated above, the ideal equalization network should be flexible enough to accommodate all naturally observed peaks and notches in the unequalized response due to resonance phenomena in the specimen and fixture. Some experimentation with new equalization networks and equalization techniques is needed to alleviate the problems involved in equalizing for a highly complex unequalized response.

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